CLAIMS

What is claimed is:

1. A method for clearance detection that maps motions of a first body and a second body for detecting a clearance between the first body and the second body, wherein the first body undergoes a first motion and the second body undergoes a second motion, the method comprising the steps of:

   a) employing a first representation for the first body;

   b) employing a second representation for the second body;

   c) employing a first mapping of the first motion, the first mapping having a first inverse mapping;

   d) employing a second mapping of the second motion, the second mapping having a second inverse mapping;

   e) employing a hierarchical minimum distance search with respect to the volumes virtually swept by the bounding volume hierarchy (BVH) representations of the first and second body under their respective motions;

   f) applying the first inverse mapping to a first direction vector and the first representation to determine a first directionally furthest location on a first volume virtually swept by a node in the BVH representation of the first body during the first motion;

   g) applying the second inverse mapping to a second direction vector and the second representation to determine a second directionally furthest location on a second volume virtually swept by a node in the BVH representation of the second body during the second motion; and

   h) detecting a clearance between the first body and the second body.

2. The method of Claim 1, further comprising the step of determining a size of the clearance.

3. The method of Claim 1, further comprising the step of determining collisions.

4. The method of Claim 1 wherein:

a) the first motion comprises a first translation concurrent with a first rotation; and

b) the second motion comprises a second translation concurrent with a second rotation.

5. The method of Claim 1 wherein:

a) the first motion comprises a first translation; and

b) the second motion comprises a second translation.

6. The method of Claim 1, wherein:

a) the first motion comprises a first rotation; and

b) the second motion comprises a second rotation.

7. The method of Claim 1 wherein:

a) the first motion comprises a rotation; and

b) the second motion comprises a translation.

8. The method of Claim 1 wherein clearance detecting is time-dependent.

9. The method of Claim 1 wherein applying the first inverse mapping to a first direction vector and the first representation to determine a first directionally furthest location on a first volume virtually swept during the first motion comprises:

a) determining a first BVH representation from the first representation, wherein the first BVH representation comprises a first tree of nodes, each of which is a convex geometric primitive;

b) applying the first inverse mapping to the first direction vector; and

c) determining a directionally furthest location on the first volume virtually swept by one of the one or more of the geometric primitives of the first tree of nodes during the first motion using the first inverse mapping.

10. The method of Claim 9 wherein applying the second inverse mapping to a second direction vector and the second representation to determine a second directionally furthest location on a second volume virtually swept during the second motion comprises:

a) determining a second BVH representation from the second representation, wherein the second BVH representation comprises a second tree of nodes, each of which is a convex geometric primitive;

b) applying the second inverse mapping to the second direction vector; and

c) determining a second directionally furthest location on the second volume virtually swept by one of the convex geometric primitives of the second tree of nodes during the second motion using the second inverse mapping.

11. The method of Claim 10 wherein detecting a clearance between the first body and the second body comprises:

a) computing a distance between a first convex hull of the first volume virtually swept by one of the convex geometric primitives of the first tree of nodes during the first motion and a second convex hull of the second volume virtually swept by one of the convex geometric primitives of the second tree of nodes during the second motion; and

b) repeating the computing step for another of the convex geometric primitives of the first tree of nodes and another of the convex geometric primitives of the second tree of nodes.

12. The method of Claim 2 wherein applying the first inverse mapping to a first direction vector and the first representation to determine a first directionally furthest location on a first volume virtually swept during the first motion comprises:

a) determining a first BVH representation from the first representation, wherein the first BVH representation comprises a first tree of nodes, each of which is a convex geometric primitive;

b) applying the first inverse mapping to the first direction vector; and

c) determining a directionally furthest location on the first volume virtually swept by one of the convex geometric primitives of the first tree of nodes during the first motion using the first inverse mapping.

13. The method of Claim 12 wherein applying the second inverse mapping to a second direction vector and the second representation to determine a second directionally furthest location on a second volume virtually swept during the second motion comprises:

a) determining a second BVH representation from the second representation, wherein the second BVH representation comprises a second tree of nodes, each of which is a convex geometric primitive;

b) applying the second inverse mapping to the second direction vector; and

c) determining a second directionally furthest location on the second volume virtually swept by one of the convex geometric primitives of the second tree of nodes during the second motion using the second inverse mapping.

14. The method of Claim 13 wherein detecting a clearance size between the first body and the second body comprises:

a) computing a distance between a first convex hull of the first volume virtually swept by one of said one or more first convex geometric primitives during the first motion and a second convex hull of the second volume virtually swept by one of said one or more second convex geometric primitives during the second motion;

b) repeating the computing step for another of said one or more first convex geometric primitives and another of said one or more second convex geometric primitives; and

c) determining a shortest distance of said distances to determine the clearance size.

15. The method of Claim 14, wherein detecting a clearance between the first body and the second body comprises:

a) computing a distance between a first convex hull of the first volume virtually swept by one of said one or more first convex geometric primitives during the first motion and a second convex hull of the second volume virtually swept by one of said one or more second convex geometric primitives during the second motion;

b) repeating the computing step for either or both of another of said one or more first convex geometric primitives and another of said one or more second convex geometric primitives; and

c) determining a shortest distance of said distances to detect a collision.

16. The method of Claim 2 wherein determining a size of the clearance comprises:

a) determining a first point on the first representation representing a shortest distance;

b) determining a second point on the second representation representing the shortest distance; and

c) calculating the size of the clearance.

17. The method of Claim 3 wherein determining a collision comprises:

a) determining a first point on the first representation representing a shortest distance;

b) determining a second point on the second representation representing the shortest distance; and

c) calculating the size of the clearance.

18. The method of Claim 10 wherein one or more of the convex geometric primitives of the first tree of nodes is selected from the group consisting of convex polyhedra, the method additionally comprising the steps of:

a) determining the directionally furthest point of a polyhedron's virtually swept volume by determining a directionally furthest vertex on that polyhedron with respect to an initial image of the first direction vector under the inverse mapping;

b) determining a transition of the directionally furthest vertex to an edge-adjacent vertex on that polyhedron due to motion of the inversely mapped first direction vector; and

c) determining subsequent changes of the directionally furthest vertex to an edge-adjacent vertex on that polyhedron due to motion of the inversely mapped first direction vector.

19. The method of Claim 18 wherein one or more of the convex geometric primitives of the second tree of nodes is selected from the group consisting of convex polyhedra, the method additionally comprising the steps of:

a) determining the directionally furthest point of a polyhedron's virtually swept volume by determining a directionally furthest vertex on that polyhedron with respect to an initial image of the second direction vector under the inverse mapping;

b) determining a transition of the directionally furthest vertex to an edge-adjacent vertex on that polyhedron due to motion of the inversely mapped second direction vector; and

c) determining subsequent changes of the directionally furthest vertex to an edge-adjacent vertex on that polyhedron due to motion of the inversely mapped second direction vector.

20. Computer software for clearance detection that maps motions of a first body and a second body for detecting a clearance between the first body and the second body, wherein the first body undergoes a first motion and the second body undergoes a second motion, said computer software comprising means for performing the steps of:

a) employing a first representation for the first body;

b) employing a second representation for the second body;

c) employing a first mapping of the first motion, the first mapping having a first inverse mapping;

d) employing a second mapping of the second motion and having a second inverse mapping;

e) employing a hierarchical minimum distance search with respect to the volumes virtually swept by the bounding volume hierarchy (BVH) representations of the first and second body under their respective motions;

f) applying the first inverse mapping to a first direction vector and the first representation to determine a first directionally furthest location on a first volume virtually swept by a node in the BVH representation of the first body during the first motion;

g) applying the second inverse mapping to a second direction vector and the second representation to determine a second directionally furthest location on a second volume virtually swept by a node in the BVH representation of the second body during the second motion; and

h) detecting a clearance between the first body and the second body.